CHAPTER 5
GRITS STATISTICS MODULES

5.1 INTRODUCTION

GRITS/STAT 5.0 contains two statistical modules for data analysis: the **GRITS Statistics Intervals Module** and the **GRITS Statistics ANOVA**, **Two-Sample, Control Chart Module**. This chapter is a reference for the software only and does not attempt statistical guidance. For statistical guidance see *Statistical Analysis of Groundwater Data: Unified Guidance*.

Table 5.1 lists all statistical methods available in the **GRITS/STAT 5.0** Statistical Modules, the Module each method is located in, the corresponding section in this reference for software guidance and the corresponding sections in the *Statistical Analysis of Groundwater Data: Unified Guidance Statistical Analysis of Groundwater Data: Unified Guidance* for statistical guidance.

Sections 5-1 through 5-5-4 pertain to both the **GRITS Statistics Intervals Module** and the **GRITS Statistics ANOVA, Two-Sample, Control Chart Module**.

Module	Statistical Method	Software Guidance	Statistical Guidance
GRITS Statistics Intervals Module	Normality Tests	Section 5.6.1	Section 5.1
	Normality Probability Plot	Section 5.6.2	Section 5.1
	Levene's Test	Section 5.6.3	Section 5.2
	Box Plots	Section 5.6.4	Section 5.2
	Parametric Confidence Intervals	Section 5.7.7	Section 12
	Non-parametric Confidence Intervals	Section 5.7.8	Section 12
	Parametric Prediction Intervals	Section 5.7.4	Section 9.2
	Non-parametric Prediction Intervals	Section 5.7.5	Section 9.2
	Parametric Tolerance Intervals	Section 5.7.1	Section 9.1
	Non-parametric Tolerance Intervals	Section 5.7.2	Section 9.1

GRITS Statistics ANOVA, Two-Sample Control Chart	Normality Tests	Section 5.6.1	Section 5.1
	Normality Probability Plots	Section 5.6.2	Section 5.1
	Levene's Test	Section 5.6.3	Section 5.2
	Box Plots	Section 5.6.4	Section 5.2
	Parametric One-Way ANOVA	Section 5.8.4	Section 8.1
	Non-parametric One-Way ANOVA (Kruskal-Wallis Test)	Section 5.8.3	Section 8.2
	Welch's t-Test	Section 5.8.6	Section 7.1
	Wilcoxon Rank-Sum Test	Section 5.8.5	Section 7.2
	Shewhart-CUSUM Control Chart	Section 5.8.1	Section 10

Table 5.1. Statistical Methods and references by **GRITS/STAT** module.

5.2 SELECTING DATA FOR ANALYSIS

The Statistics modules in **GRITS/STAT 5.0** use the data directory last selected in the Select a Facility option of the DATA MENU in **GRITS Database**.(See Section 3.3). Follow the steps below to select a data directory for analysis.

1. Start **GRITS/STAT 5.0.** (See Section 2.4.)

2. Launch **GRITS Database** from the **GRITS Main Menu**.

3. Use the up and down arrow keys to highlight the Select a Facility option of the DATA MENU and press <**Enter**> or simply press <**S**>.

4. Press <**F2**>. A Source Path prompt appears on your screen.

5. At the Source Path: prompt type the full path specification for the directory that contains the data you wish to analyze.

   Example:
   The directory that contains the data to be analyzed is C:\ABCLAND. To set the data directory to C:\ABCLAND:

a. Hold the <**Ctrl**> and <**Y**> keys down simultaneously to clear the current source path.
b. Type:
C:\ABCLAND <**Enter**>

6. A list of Facilities stored in the selected directory appears on your screen. Use the up and down arrow keys to highlight the desired Facility and press <**Enter**>. The statistics modules are now set to look at the data stored in the selected data directory.

5.3 USEFUL MENU KEYSTROKES

The statistics modules use Lotus® 1-2-3 style menus. This means that the menu options for the menu level you are currently on will run horizontally across the top of your screen. The most commonly used keystrokes used in the statistics modules and tasks are listed in Table 5.2.

Keystrokes	**Description**
<**Esc**>	Backs out one menu level
<**Enter**>	Executes currently highlighted menu option
</>	Shortcut to the top most level of the Statistics module menu. (i.e., where the menu options are: DataSet Methods GraphicsPrinter Exit)
<←>, <→>, <↑>, <↓>	Move between menu option on the current menu level.

Table 5.2. Useful keystrokes for the statistics modules.

5.4 MANAGING DATASETS

This section details loading, saving and deleting data sets in the **GRITS/STAT 5.0** statistics modules. This section pertains to both statistics modules.

A data set consists of observations from a specified group of wells at a given facility for a given constituent collected between a start and end date. Loading data into a statistics module is basically a *database query* building exercise. A *database query* defines a subset of data to load for analysis. In the statistics module the database query is constructed by filling the prompts and building the list of wells on the initial screen (Figure 5.1).

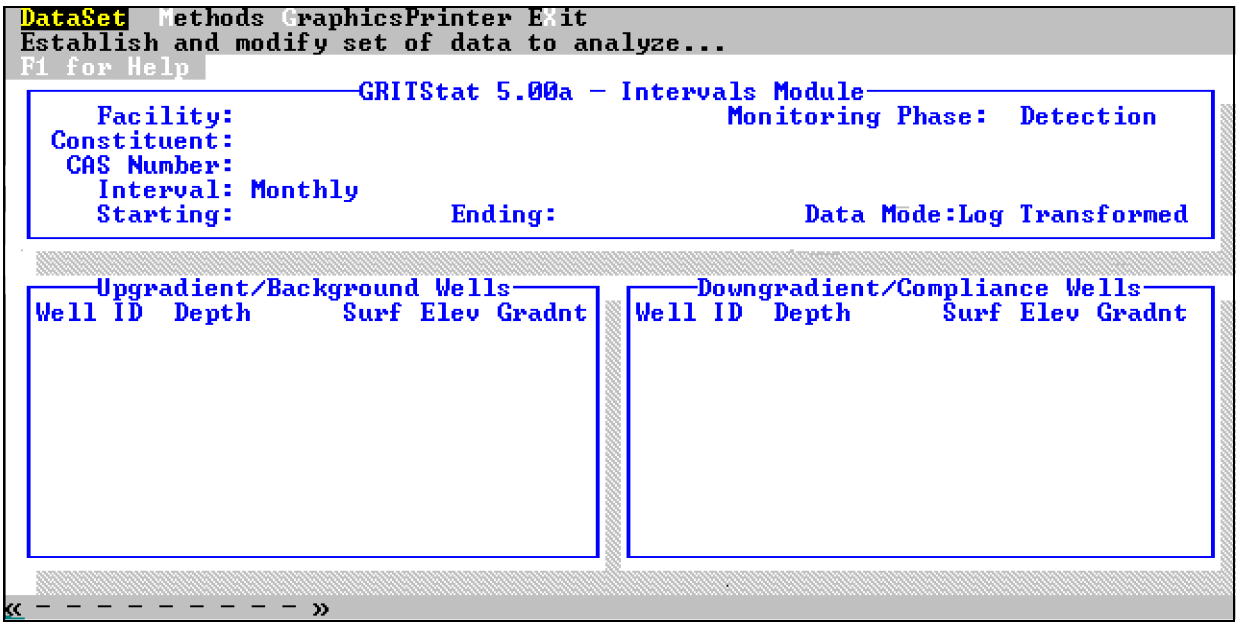


Figure 5.1. The initial **GRITS/STAT 5.0** statistics module screen.

5.4.1 CREATING DATASETS

Follow the steps below to load data into a GRITS Statistics module. The steps are identical for both modules.

1. If **GRITS/STAT 5.0** is not running start **GRITS/STAT 5.0** (See section 2.4).

2. Use the up and down arrow keys to highlight the desired GRITS Statistics module and press <**Enter**>. A screen similar to Figure 5.1 should appear. *(For the examples that follow the **GRITS Statistics, Intervals Module** will be used).*

3. When selecting data for analysis, items under the DataSet menu option will be used. A diagram of the menu items used to create and load a data set for analysis are shown in Figure 5.2. Use the left and right arrow keys to highlight DataSet and press <**Enter**> or simply press <**D**>.

> **Note:** Menu items in the Statistics modules may be executed by highlighting the desired item and pressing <**Enter**> or by pressing the item's trigger key. The trigger key will appear in a different color than the rest of the item's text. The trigger keys for the items in the DataSet menu are underlined in Figure 5.2.

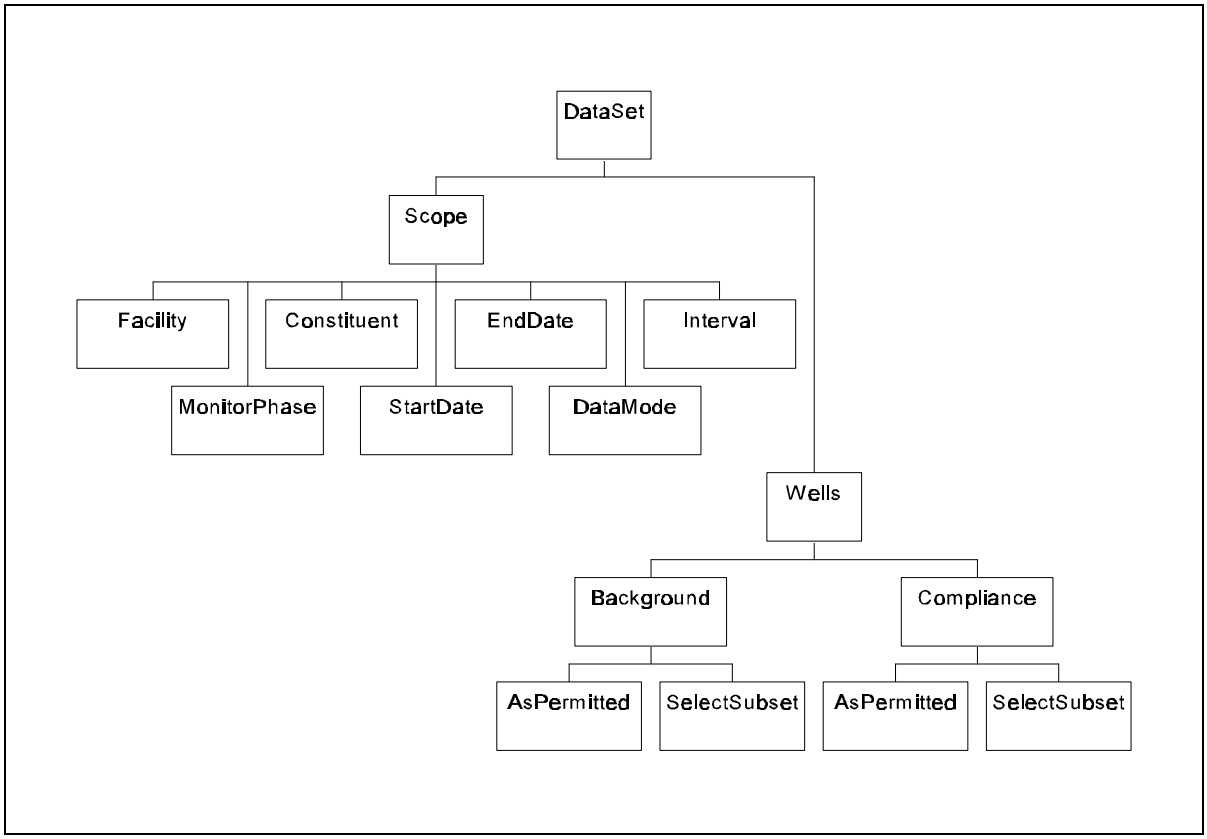


Figure 5.2. GRITS Statistics DataSet menu items.

4. Press <**S**> to descend into the Scope Menu.

5. Press <**F**> to select the Facility option. A list of Facilities in the currently selected data directory appears in a pop-up list as shown in Figure 5.3.

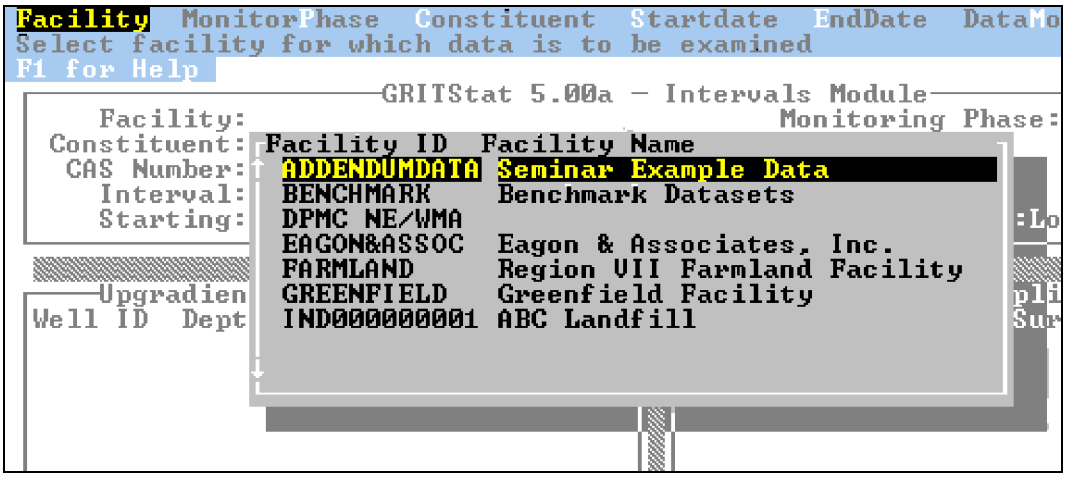


Figure 5.3 The DataSet|Scope|Facility pop-up displays all Facilities with data saved in the currently selected data directory.

Note:	If the desired Facility does not appear in the list it is probably in a different data directory. If you need to select a different data directory exit the statistics module and follow the steps in section 5.2.

Use the up and down arrow keys to highlight the desired Facility and press **<Enter>**.

The statistics module will now limit itself to only those constituents, wells and sampling events from the selected Facility.

6. Press **<P>** for the MonitorPhase option. The MonitorPhase option sets the text that appears at the top of some of the reports produced in the statistics module. This option has no effect on the way statistics are computed.

   The three options are Detection, Compliance and Corrective. Use the left and right arrow keys and highlight the appropriate choice and press **<Enter>** or simply press the appropriate trigger key.

   Press **<Esc>** to return to the Scope menu.

7. Press **<C>** for the Constituent option. A pop-up that lists all parameters entered into **GRITS/STAT 5.0** for the selected facility appears as shown in Figure 5.4.

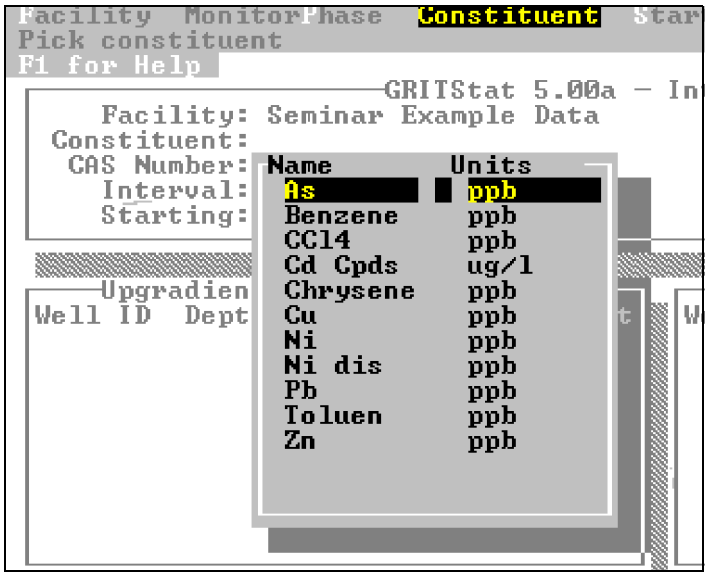


Figure 5.4. The DataSet|Scope|Constituent pop-up lists all parameters entered for the currently selected Facility.

Use the up and down arrow keys and highlight the desired constituent and press **<Enter>**.

8. Press **<S>** for the StartDate option. The statistics module will load observations with sample dates greater than or equal to the Start Date and less than or equal to the End Date.

   The first Sample Date on file for the selected facility will automatically appear next to the Starting: prompt as shown in Figure 5.5.

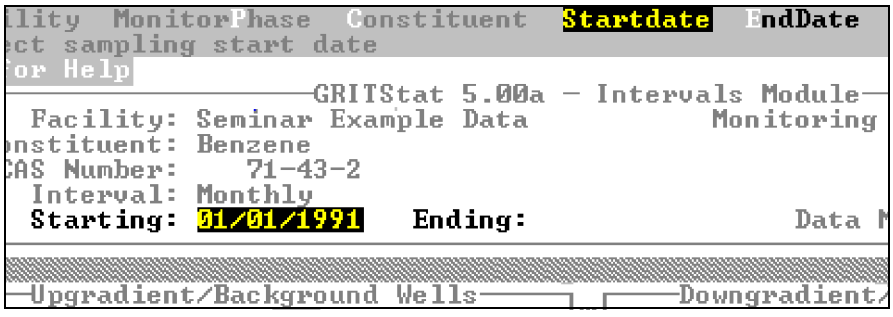


Figure 5.5 Benzene observation with a sample date greater than or equal to Jan. 1, 1991 and less than or equal to the Ending date will be included in this dataset.

If the default Starting date is acceptable press <**Enter**>.

If you desire a different date simply type it in at the Starting prompt and press <**Enter**>. Note that when typing in a new Starting or Ending date the dates must be entered in MMDDCCYY order (i.e., 2-digit month with a leading zero if necessary, 2-digit day with a leading zero if necessary and a 4-digit year).

9. Press <**E**> for the EndDate option.

The last Sample Date on file for the selected facility will automatically appear next to the Ending: prompt.

If the default Ending date is acceptable press <**Enter**>.

If you desire a different date simply type it in at the Ending prompt and press <**Enter**>. Note that when typing in a new Starting or Ending date the dates must be entered in MMDDCCYY order (i.e., 2-digit month with a leading zero if necessary, 2-digit day with a leading zero if necessary and a 4-digit year).

10. Press <**M**> for DataMode. A pop-up of the two available choices as shown in Figure 5.6 appears on your screen.

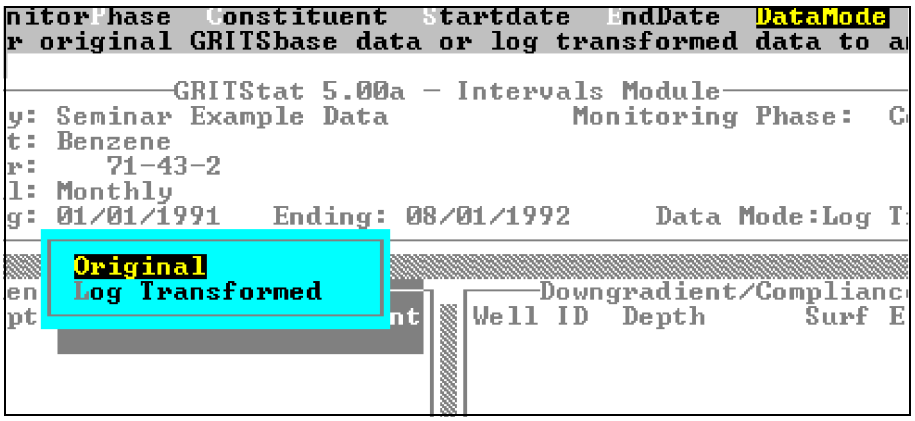


Figure 5.6. The DataSet | Scope | DataMode option sets the default scale used by the methods in the statistics modules.

The Data Mode specifies the default scale of the observations used in the statistical methods. The two options available in the statistical modules are Original and Log Transformed.

The Original option will set the default scale to raw untransformed data. The Log Transform scale will set the default scale to the natural logarithms of the

observations.

> **Note:** Most methods in the GRITS/STAT 5.0 statistics module have an override for the Data Mode setting.

Use the up and down arrow keys to highlight the desired default Data Mode setting and press <**Enter**>.

11. Press <**I**> for the Interval option. A pop-up of sampling intervals appears as shown in Figure 5.7.

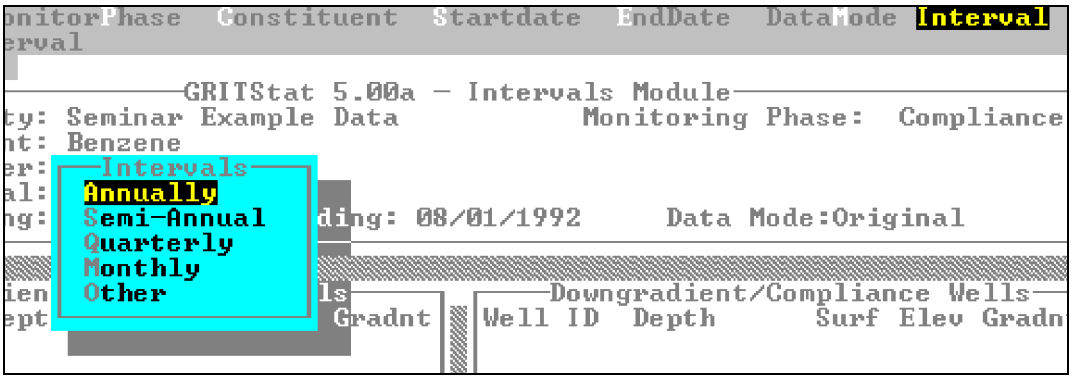


Figure 5.7 The DataSet | Scope | Interval setting sets the text that appears as the Sampling Interval on some reports generated in the statistics modules.

The Interval option sets text that is displayed at the top of some of the reports generated by the statistical modules. This option has no effect on the computation of the methods.

Use the up and down arrow keys to highlight the desired Interval setting and press <**Enter**>.

12. You are now ready to build the list of background wells. Press <**Esc**> to back out to the DataSet menu. Your menu should now look like Figure 5.8.

Figure 5.8. The DataSet menu.

13. Press <**W**> for the Wells menu.

14. Press <**B**> for the Background menu.

There are two choices at this level: AsPermitted and SelectSubset.

The AsPermitted option only allows you to select wells that have been entered in **GRITS Database** or **GRITS SAGE** as upgradient wells.

The SelectSubset option allows you to select any well regardless of it's gradient.

15. Press <**S**> for the SelectSubset option. A pop-up list of wells appears on your screen as shown in Figure 5.9. This pop-up list allows you to tag all wells that you want to load as Background or Upgradient wells.

For each well that you want to load as a background *(or upgradient)* well:

a. Use the up and down arrow keys to highlight the desired well.
b. Press <**Enter**> to tag the well.

> **Note:** <**Enter**> is a toggle. If a well is not tagged the <**Enter**> will tag the well. If a well is tagged the <**Enter**> will un-tag the well.

Once you have tagged all desired background wells press <**Esc**>.

At this point you have completed the query for background observations. The statistics module will now load background observations.

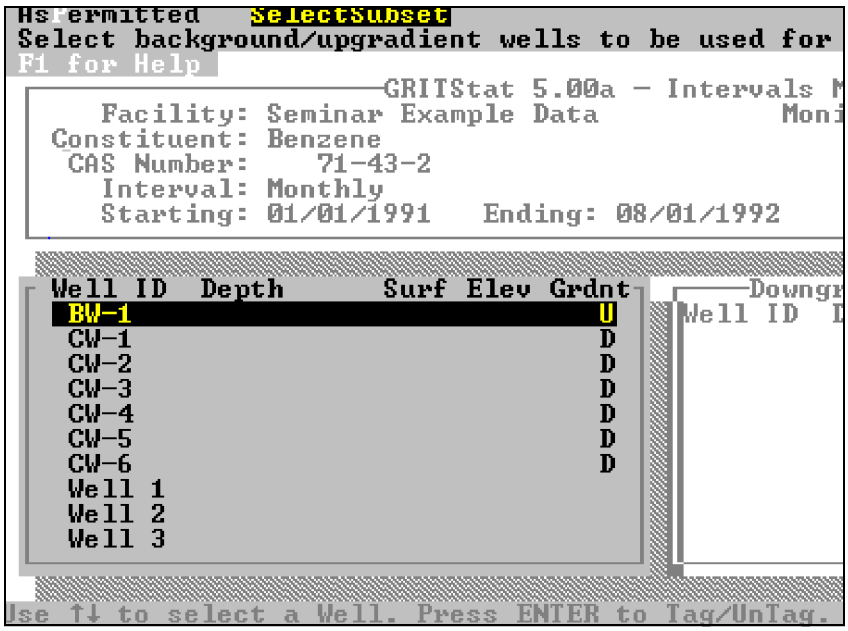


Figure 5.9. The DataSet | Wells | Background | SelectSubset list box allows you to tag all wells to be considered Upgradient in this dataset.

16. Press <**Esc**> to back out to the Wells menu. Your menu should now look like Figure 5.10.

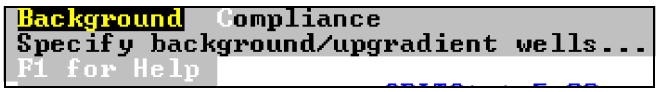


Figure 5.10. The DataSet | Wells menu.

17. Press <**C**> for the Compliance menu. There are two choices in the Compliance menu: AsPermitted and SelectSubset.

    The AsPermitted option only allows you to select wells that have been entered as downgradient or compliance wells in **GRITS Database** or **GRITS SAGE**.

    The SelectSubset option allows you to select wells for use as compliance or downgradient wells in the dataset regardless of their gradient designation.

18. Press <**S**> for the SelectSubset option. A pop-up list of wells appears as shown in Figure 5.11. This pop-up list allows you to tag all wells that you want to load as compliance or downgradient wells in this dataset. Note that any well that has already been selected as a background well will appear grayed in the list and may not be selected.

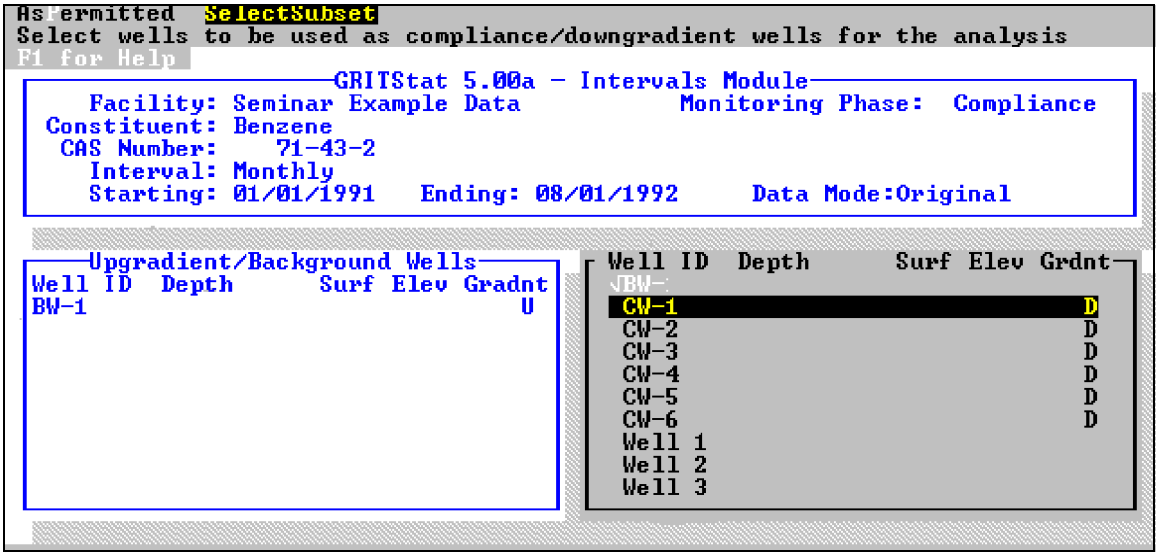


Figure 5.11. The DataSet | Scope | Wells | Compliance | SelectSubset pop-up allows you to tag compliance wells for the data set.

For each well that you wish to tag as a compliance or downgradient well:

a. Use the up and down arrow keys to highlight the desired well.
b. Press **<Enter>** to tag the well.

> **Note:** **<Enter>** is a toggle. If the highlighted well is not tagged press **<Enter>** to tag the well. If the highlighted well is tagged press **<Enter>** to un-tag the well.

When you are finished tagging all desired compliance wells press **<Esc>**.

At this point you have completed the definition of the data set and all background and compliance well observations should be loaded.

> **Note:** To avoid repeating steps 1 through 18 every time you want the data set you just created proceed to section 5.4.2.

5.4.2 SAVING DATA SETS

Data sets constructed using the instructions in section 5.4.1 may be saved. This prevents you from having to laboriously repeat the 18 steps in detailed in section 5.41 every time that you want to load a particular data set.

Saved data sets can be loaded with the DataSet | File | Retrieve (see section 5.4.3) menu option.

Follow the steps below to save the currently active data set.

> **Note:** The steps below assume that a **GRITS/STAT 5.0** statistics module is running and a complete data set with observations are loaded.

1. Press the **<Esc>** key repeatedly until you are at the top-most level of the statistics

Figure 5.12. The top-most menu level.

module menu. Your menu should look like Figure 5.12.

2. Press **<D>** for the DataSet menu.

3. Press **<F>** for the File menu.

4. Press <**S**> for Save. The pop-up shown in Figure 5-13 appears on your screen.

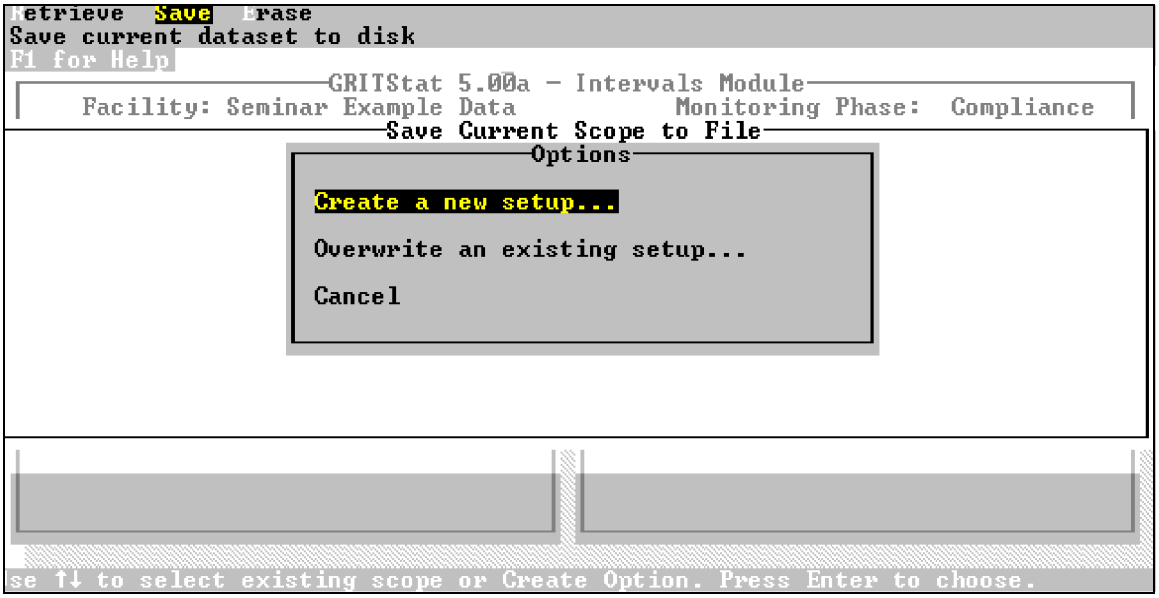


Figure 5.13. Options under DataSet | File | Save.

Use the Create a new setup... option to save a data set for the first time.

Use the Overwrite an existing setup... option if you want to save changes to an existing data set. (i.e., A well has been added to or removed from the setup, the Beginning or Ending date has changed, etc.)

Use the Cancel option to abort.

Highlight the desired option and press <**Enter**>.

5. If you selected the Create a new setup option... the dialog shown in figure 5.14 appears on your screen.

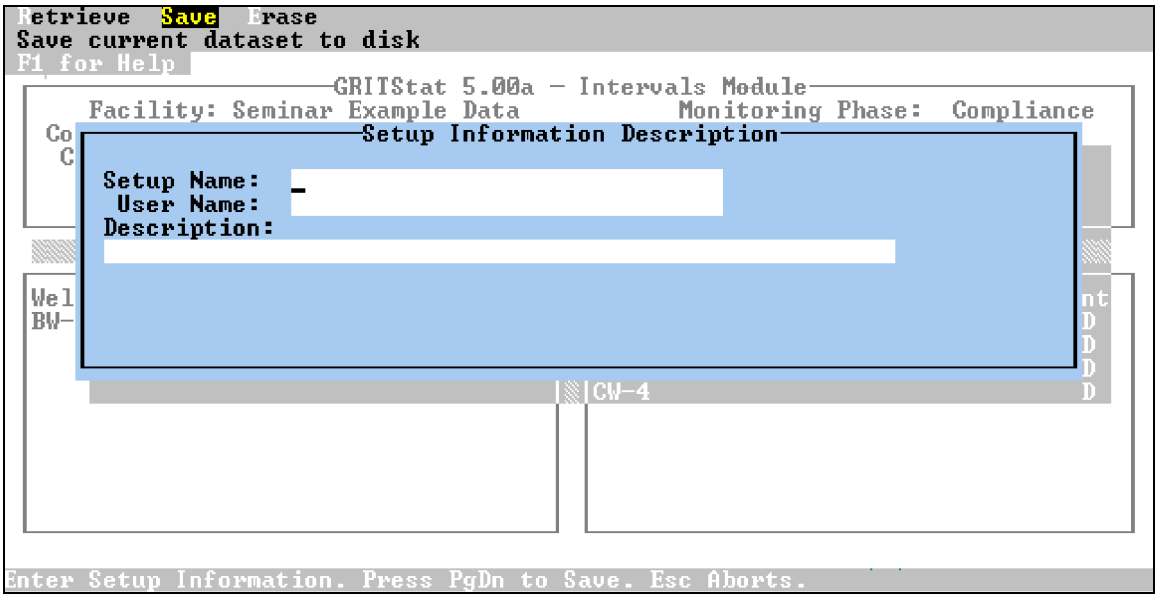


Figure 5.14. The Create a new setup dialog.

The Setup Name is the free format textual description that will appear in the list of previously defined data sets when you next load the data set (see section 5.4.3). Type in a Setup Name that is meaningful to you and press <**Enter**>. Setup Name may be up to 30 characters in length.

The User Name is optional. User Name also appears in the list of previously defined data sets .

Description is optional. The Description field is free format textual description that does not appear in the list of previously defined data sets.

Press <**Page Down**> to save this data set.

Press <**Esc**> to abort saving.

6. If you selected the Overwrite an existing setup... option the dialog pop-up list of previously saved setups as shown in figure 5.15 appears on your screen.

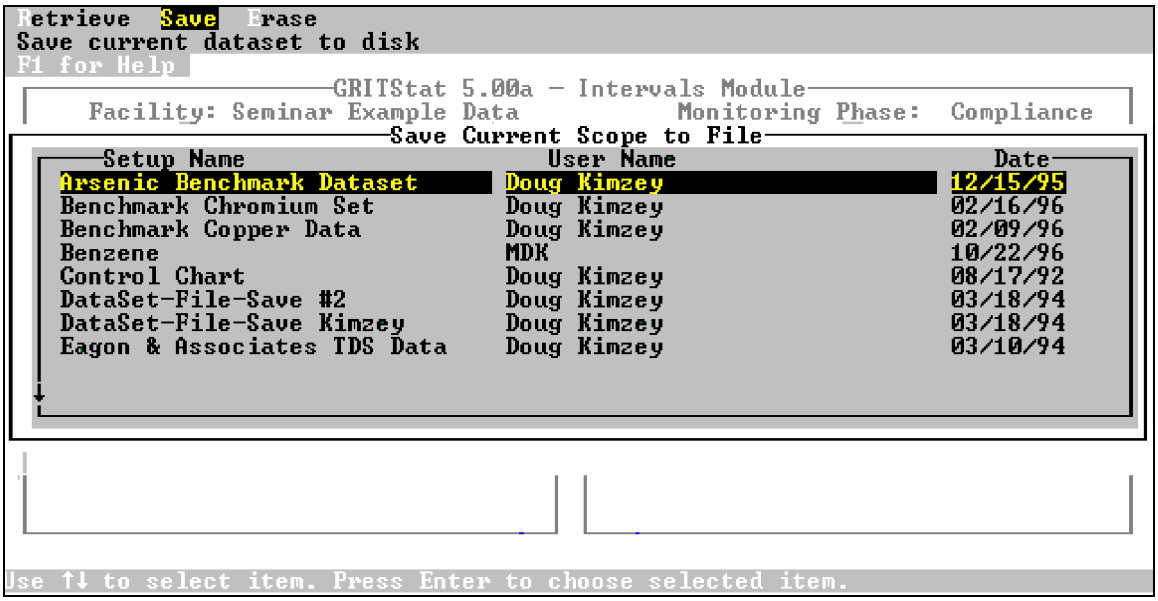


Figure 5.15 The Overwrite an existing setup... list box allows you to select the previously saved data set that you want to overwrite.

Use the up and down arrow keys to highlight the data set that you want to overwrite.

Press <**Enter**> to overwrite the highlighted data set or

Press <**Esc**> to abort the save.

5.4.3 LOADING PREVIOUSLY SAVED DATA SETS

This section walks you through loading a data set that was saved with the procedure described in section 5.4.2. To load a previously saved data set follow the instructions below.

1. Press the <**Esc**> key repeatedly until you are at the top-most level of the statistics module menu. Your menu should look like figure 5.12.

2. Press <**D**> for the DataSet menu.

3. Press <**F**> for the File menu.

4. Press <**R**> for Retrieve. A pop-up list of previously saved data sets in alphabetical order appears as shown in figure 5.16.

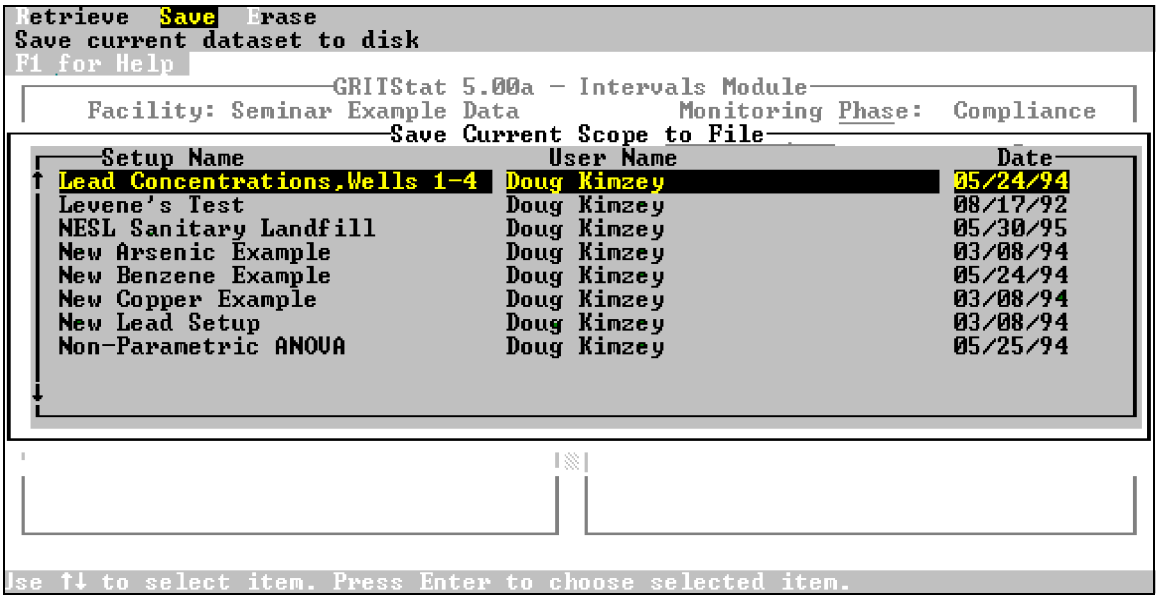


Figure 5.16. The pop-up list of previously saved data sets under DataSet | File | Retrieve.

Use the up and down arrow keys to highlight the desired data set and press **<Enter>** to load it.

Press **<Esc>** to cancel DataSet | File | Retrieve.

Note: The list of previously saved data sets is saved in the selected data directory. If the list does not contain the desired data set you may need to switch data directories (see section 5.2).

5.4.4 DELETING PREVIOUSLY DEFINED DATA SETS

The **GRITS/STAT 5.0** statistics modules have a DataSet | File | Erase option for removing unwanted data sets. It should be understood that this option only removes a data sets listing in the list of previously saved data sets and does not delete the data. After a data set is erased with the DataSet | File | Erase option, the data set may be reconstructed by following the steps in section 5.4.1.

If you wish to delete the actual data you must use either **GRITS Database** or **GRITS SAGE**.

To remove a previously saved data set from the list that appears under DataSet | File | Retrieve follow the steps below.

1. Press the **<Esc>** key repeatedly until you are at the top-most level of the statistics module menu. Your menu should look like figure 5.12.

2. Press <**D**> for the DataSet menu.

3. Press <**F**> for the File menu.

4. Press <**E**> for Erase. A pop-up list of previously saved data sets appears as shown in figure 5.16. Use the up and down arrow keys to highlight the data set you want to remove from the list and press <**Enter**>.

5. The warning shown in figure 5.17 appears on your screen. If you want to remove this data set highlight Yes and press <**Enter**>. If you are having second thoughts highlight No and press <**Enter**>.

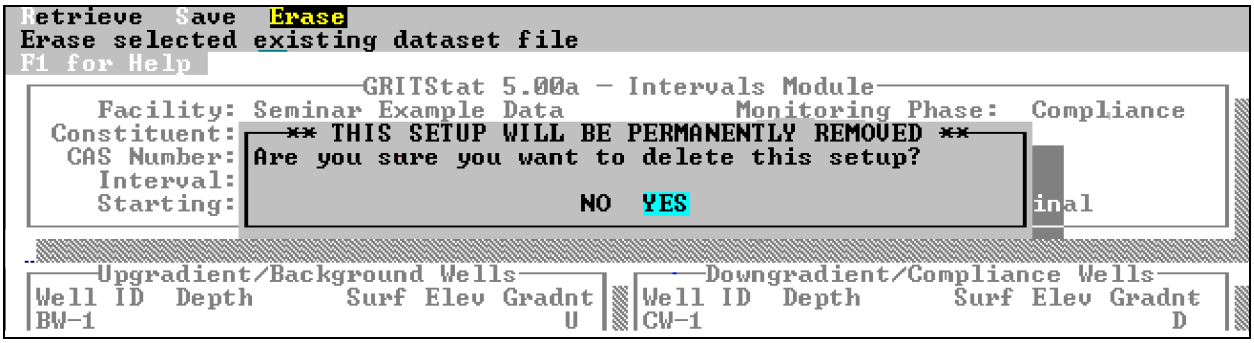


Figure 5.17. Warning shown to allow users to change their minds prior to removing a data set from the list of previously save data sets.

5.5 THE DATASET VIEW OPTIONS

The DataSet | View menu contains options that allow you to view and print a textual summary of the currently loaded data set, produce time series plots of the data, setup a filter based on measurement qualifiers and view system status. The options under the DataSet | View menu are shown in Figure 5-18.

5.5.1 DATASET VIEW SUMMARIZE

The DataSet | View | Summarize option is used to view observations and summary statistics well by well. The instructions below assume that a data set is currently loaded in the GRITS Statistics module.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**D**> to descend into the DataSet menu.

3. Press <**V**> to descend into the View menu.

4. Press <**S**> to show the Well Summary Statistics dialog as shown in Figure 5-19. Table 5-2 describes the summary statistics displayed for each well:

Column	Description
N	Number of observations
%ND	Percentage of Nondetects
Max Value	Maximum observation
Min Value	Minimum observation
Mean	Mean of the N observations
Std Dev	Standard Deviation of the N observations

Table 5-2. Well Summary Statistics shown in DataSet | View | Summarize.

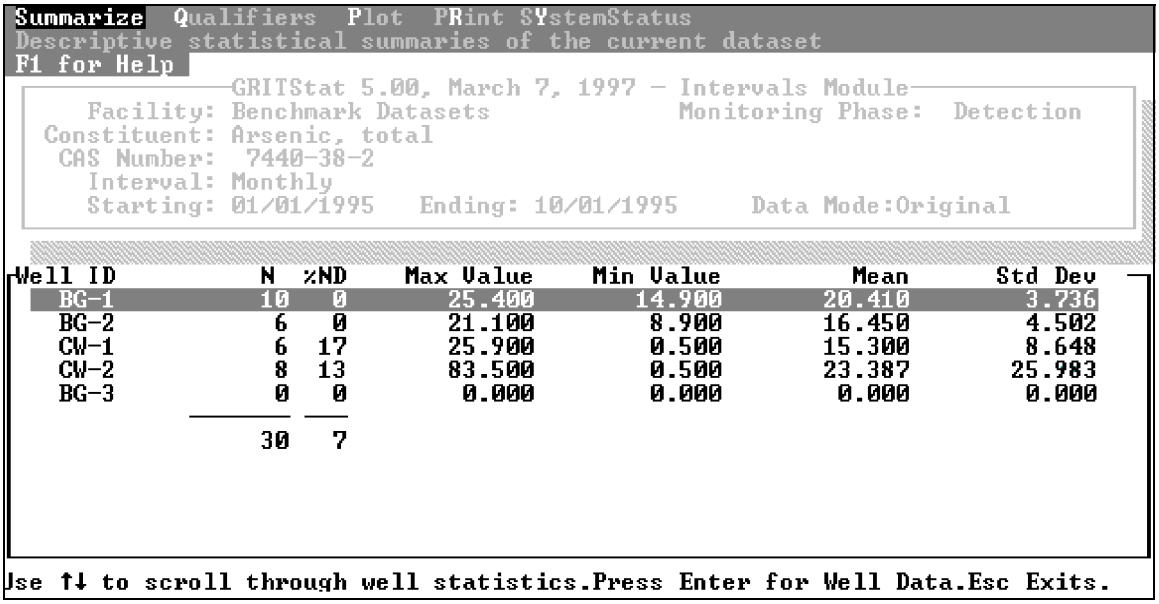


Figure 5-19. Well Summary Statistics dialog under DataSet | View | Summarize.

> **Note:** If the Data Mode is set to Log Transform the displayed summary statistics will be computed on the natural logarithms of the observations.

5. To view the individual observations from a given well use the up and down arrow keys to highlight the desired well and press <**Enter**>. The Well Observations dialog appears on your screen as shown in Figure 5-20. Use the up and down arrow keys to scroll through the observations for the selected well. Table 5-3 describes the columns in the observations table.

Column	Description
Date	Sampling date that the observation was collected.
Original Data	Observation on the original scale
Units	Measurement units
Ln Data	Natural Logarithm of the observation
Qualifier	Measurement Qualifier

Table 5-3. Columns in the observations table.

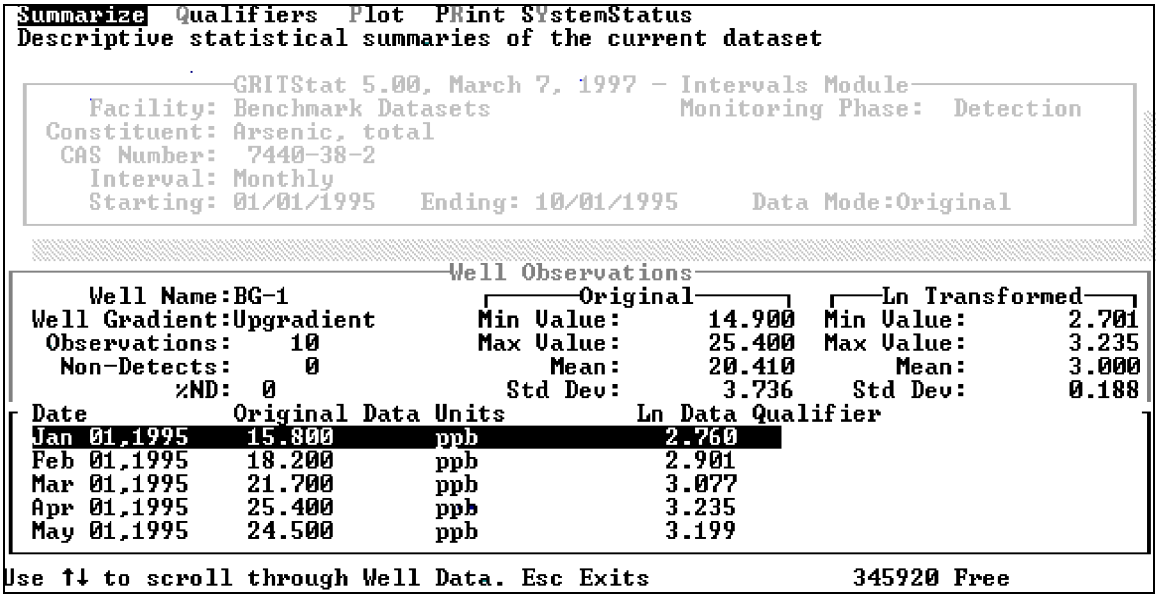


Figure 5-20. The Well Observations dialog.

Press <**Esc**> or <**Enter**> to return to the Well Summary Statistics dialog (Figure 5-19). Press <**Esc**> at the Well Summary Statistics dialog to return to the DataSet | View menu.

To obtain a printout of the observations and well summary statistics see section 5.5.4.

5.5.2 DATASET VIEW QUALIFIERS

The DataSet | View | Qualifiers option allows you to exclude observations from the data set based on their measurement qualifiers. (See section 3.5.1.1 for assigning a measurement qualifier to an observation). The instructions below assume that a data set is loaded in the GRITS Statistics module.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**D**> to descend into the DataSet menu.

3. Press <**V**> to descend into the View menu.

4. Press <**Q**> to execute the Qualifiers option. The Filter Qualified Data dialog shown in Figure 5-21 appears on your screen.

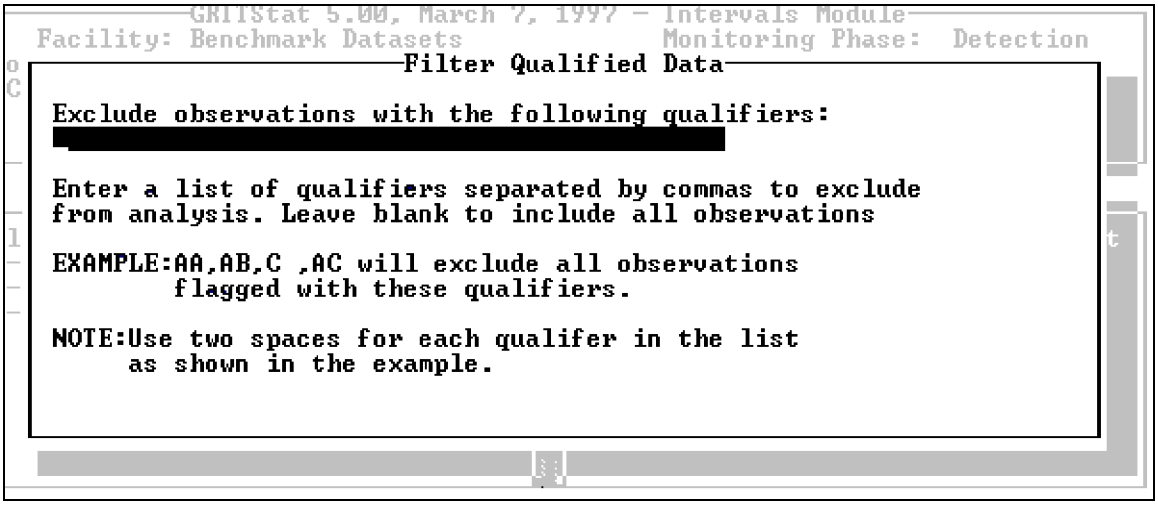
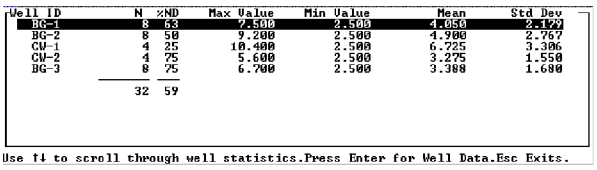


Figure 5-21. The Filter Qualified Data dialog.

5. Enter a list of qualifiers separated by commas. Use two characters for each qualifier you enter. After you have specified the qualifier list press <**Enter**>. Any observation flagged with a measurement qualifier entered in the Filter Qualified Data dialog will be excluded from analysis.

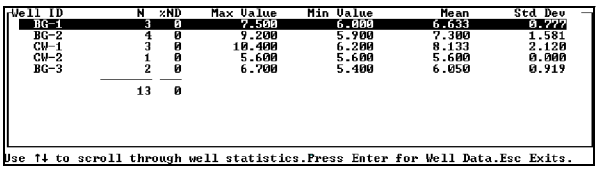
   Example: Nondetects in a given data set have been flagged by the user with the measurement qualifier U. To exclude all nondetects from the data set to produce a Detects Only Probability Plot U is entered in the Filter Qualified Data dialog prior to running the Probability Plot method. Figure 5-22 shows the Well Summary Statistics dialog prior to entering U in the Filter Qualified Data dialog. Figure 5-23 shows the Well Summary Statistics dialogs after the filter has been applied.



Well ID	N	%ND	Max Value	Min Value	Mean	Std Dev
BG-1	8	63	7.500	2.500	4.050	2.177
BG-2	8	50	9.200	2.500	4.986	2.767
CW-1	4	25	10.400	2.500	6.725	3.396
CW-2	4	75	5.600	2.500	3.275	1.550
BG-3	8	75	6.700	2.500	3.388	1.680
	32	59				

Use ↑↓ to scroll through well statistics.Press Enter for Well Data.Esc Exits.

Figure 5-22. The Well Summary Statistics dialog prior to applying the filter.



Well ID	N	%ND	Max Value	Min Value	Mean	Std Dev
BG-1	3	0	7.500	6.000	6.633	0.777
BG-2	1	0	9.200	5.900	7.300	1.581
CW-1	3	0	10.400	6.200	8.133	2.120
CW-2	1	0	5.600	5.600	5.600	0.000
BG-3	2	0	6.700	5.400	6.050	0.919
	13	0				

Use ↑↓ to scroll through well statistics.Press Enter for Well Data.Esc Exits.

Figure 5-23. The Well Summary Statistics dialog after the filter is applied.

To clear the filter so that all observations are included regardless of the measurement qualifiers go to the Filter Qualified Data dialog and hold the **<Ctrl>** and **<Y>** keys down at the same time to clear the qualifiers list. Press **<Enter>**.

5.5.3 DATASET | VIEW | PLOT

The options under the DataSet | View | Plot option are used to produce plots of analyte vs. time. Each trace on the plot represents an individual well. The instructions below assume that a data set is loaded in the GRITS Statistics module.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**D**> to descend into the DataSet menu.

3. Press <**V**> to descend into the View menu.

4. Press <**P**> to descend into the Plot menu. The options under the Plot menu are summarized in Table 5-4.

   The Background, Compliance, and PlotSelected options produce the actual plots. Prior to displaying the plots the Plot Setup dialog (section 5.6.3.1) allows you to customize the plot. Press <**Page Down**> at the Plot Setup dialog to proceed to the time series plot (Figure 5-24) or press <**Esc**> to return to the DataSet | View | Plot menu.

   The Select option of the DataSet | View | Plot menu is used to include or exclude individual wells from plotting and analysis (section 5.6.3.2).

   Instructions for printing a plot are detailed in section 5.6.3.3.

Plot option	Description
Background	Time series plot of Background Wells only.
Compliance	Time series plot of Compliance Wells only.
PlotSelected	Times series plot of selected Background and Compliance Wells.
Select	Allows user to include/exclude wells from time series plots and analysis.
GraphicsPrinter	Allows users to specify a graphics printer and port.

Table 5-4. Plot menu options.

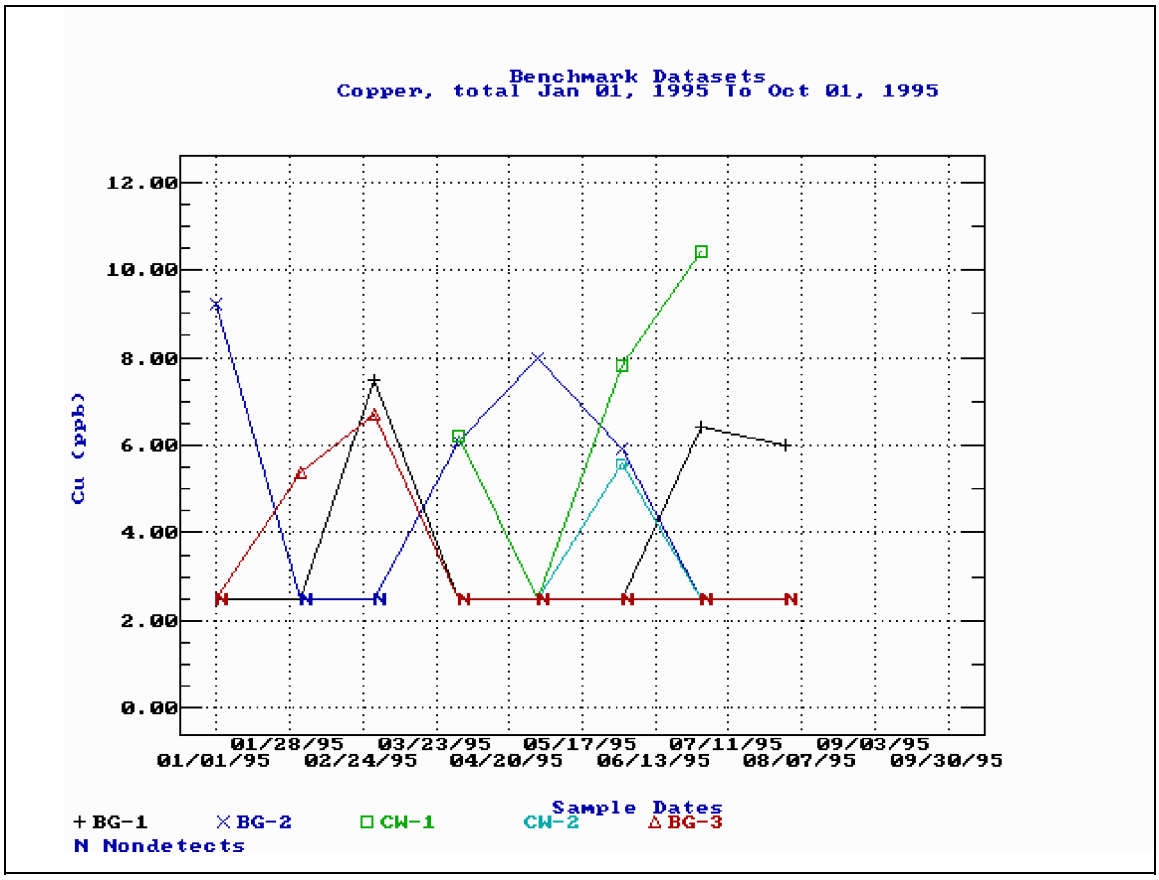


Figure 5-24. Time series plot produced by using the DataSet | View | Plot | PlotSelected option.

5.5.3.1 CONFIGURING PLOTS

Upon executing the Background, Compliance or PlotSelected option of the DataSet | View | Plot menu the Plot Setup dialog appears on your screen (Figure 5-25). The Plot Setup dialog allows you to customize the time series plot scales and titles.

The entries of the Plot Setup dialog are described in Table 5-5. Use the up and down arrow keys to navigate between entries. Press <**Page Down**> to proceed to the plot or press <**Esc**> to abort and return to the DataSet | View | Plot menu.

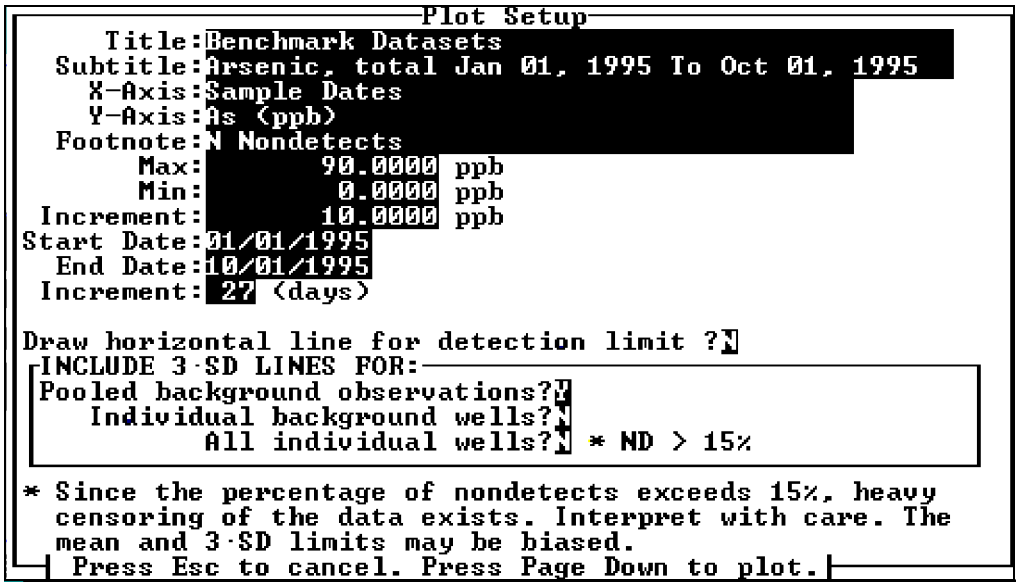


Figure 5-25. The Plot Setup dialog for the Background, Compliance, and PlotSelected options of the DataSet | View | Plot dialog.

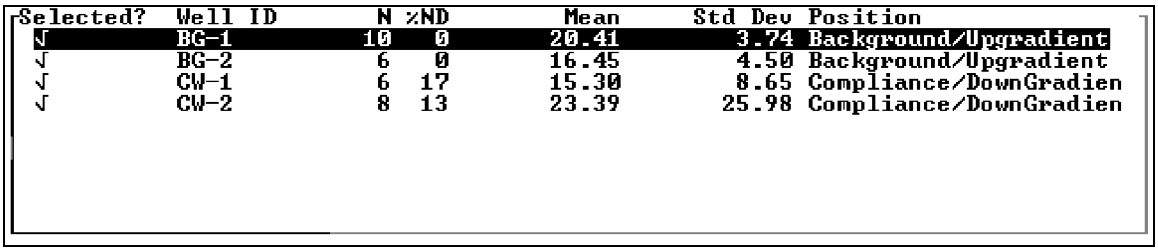
Plot Setup dialog entry	**Description**
Title	Plot Title
Subtitle	Plot Subtitle
X-Axis	X-Axis Title
Y-Axis	Y-Axis Title
Footnote	Plot Footnote
Max	Maximum analyte concentration to plot
Min	Minimum analyte concentration to plot
Increment	Size of division between adjacent tick marks on the Y-Axis.

Start Date	Earliest sampling date to plot
End Date	Last sampling date to plot
Increment	Number of days between tick marks on the X-Axis.
Draw horizontal line for detection limit?	If Y is entered a horizontal red dashed line will be drawn at the analyte's detection limit.
INCLUDE 3•SD LINES FOR	
Pooled background observations?	If Y is entered horizontal lines will be drawn for the mean of the pooled background wells and the mean ± 3·SD.
Individual background wells?	If Y is entered mean and mean ± 3·SD lines are drawn for each individual background well.
All individual wells?	If Y is entered mean and mean ± 3·SD lines are drawn for each individual well.

Table 5-5. Plot Setup dialog entries.

5.5.3.2 INCLUDE / EXCLUDING WELLS FROM PLOTS AND ANALYSIS

The Select option of the DataSet | View | Plot menu is used to toggle a well's *Selection Flag*. If a well's *Selection Flag* is **ON** the well is used in all plots and methods. If the well's *Selection Flag* is **OFF** the well is excluded from plots and methods. Press **<S>** from the DataSet | View | Select menu to execute the Well Selection dialog shown in Figure 5-26. Note that the Well Selection dialog can also be accessed by some of the methods in **GRITS Statistics Intervals Module**.



Selected?	Well ID	N	%ND	Mean	Std Dev	Position
√	BG-1	10	0	20.41	3.74	Background/Upgradient
√	BG-2	6	0	16.45	4.50	Background/Upgradient
√	CW-1	6	17	15.30	8.65	Compliance/DownGradien
√	CW-2	8	13	23.39	25.98	Compliance/DownGradien

Figure 5-26. The Well Selection dialog.

Use the up and down arrow keys to highlight a well. Press <Enter> to toggle the well's *Selection Flag*. A check mark (√) appears in the Selected? column of the Well Selection dialog if the well's *Selection Flag* is **ON**.

5.5.3.3 PRINTING PLOTS

There are several methods for printing plots from the GRITS Statistics modules. If you are running **GRITS/STAT** from an MS DOS Window in Windows 3.x or Windows 95 and use a word processor such as Microsoft® Word or Corel® WordPerfect the easiest method is to copy and paste the plots into a word processor document.

If you have a local printer attached directly to your PC you may specify a printer with the GraphicsPrinter option of the DataSet | View | Plot menu and press <**Alt**> <**P**> while viewing the plot. Instructions for each method are presented below.

Printing plots in MS Windows

If you are running **GRITS/STAT** in a DOS Window from MS Windows and are familiar with a word processor package follow the steps below.

1. While viewing a plot (i.e., Time Series, Box Plot, Probability Plot) in a GRITS Statistics module hold the <**Alt**> and <**Print Screen**> keys down at the same time. This will copy the plot to the clipboard.

2. Switch to your word processor and use the Edit | Paste option to paste the plot into your document. For information on formatting the plot consult your word processor's documentation.

3. Use the File | Print option of your word processor to print the plot.

Printing plots to a local printer

If you have a local printer attached to your PC and simply wish to print a plot follow the steps below.

1. If you have not set up a graphics printer go to the GraphicsPrinter menu under DataSet | View | Plot. The GraphicsPrinter option has two options: PrinterType and Port.

    a. Press <**T**> to execute the PrinterType option. A pop-up dialog appears and shows the currently selected printer (Figure 5-27).

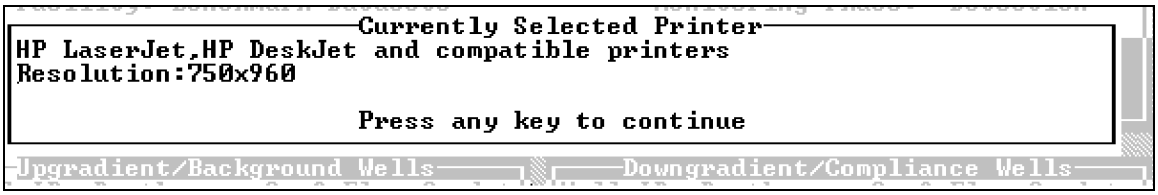


Figure 5-27. The Currently Selected Printer pop-up dialog.

If the printer shown in the Currently Selected Printer pop-up is the desired printer press <**Esc**> to return to the DataSet | View | Plot | GraphicsPrinter menu.

If the printer shown is not the desired printer press <**Enter**>. A pop-up list of printers appears as shown in Figure 5-28.

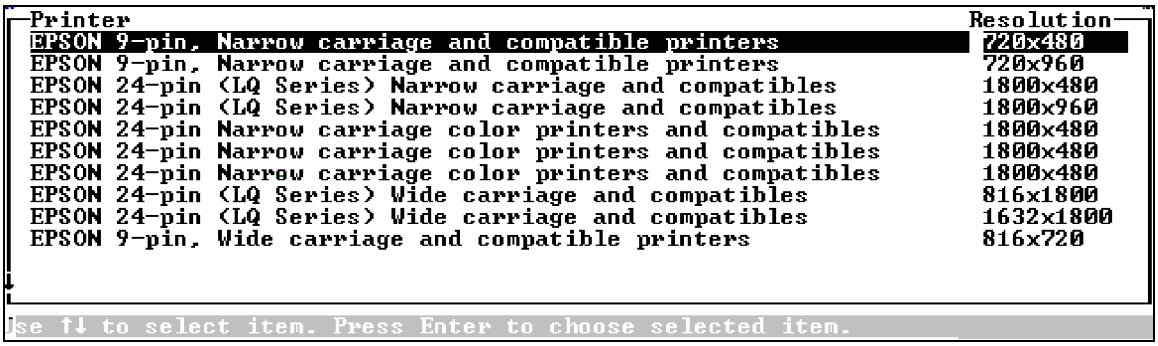


Figure 5-28. The Printer Type dialog.

Use the up and down arrow keys to highlight the desired printer and press <**Enter**>.

Note: Your exact printer type may not appear in the list. Choose the closest printer to your printer type.

b. Press <**P**> to choose the Port option of the DataSet | View | Plot | GraphicsPrinter menu. The Port dialog appears as shown in Figure 5-29. Use the up and down arrow keys to highlight the port that your printer is attached to and press <**Enter**>. If your printer is attached to LPT3: or you want to print the plot to a file highlight the Filename option and press <Enter>. The Graph File pop-up dialog will appear as shown in Figure 5-30. Enter a legal MS DOS filename or a port (i.e., LPT3:) and press <**Enter**>.

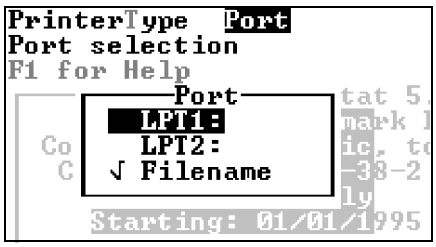


Figure 5-29. The Port dialog

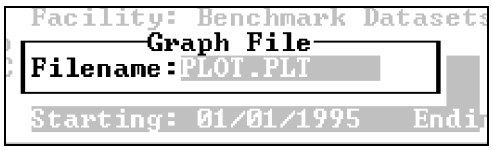


Figure 5-30. The Graph File dialog

2. While viewing a plot (i.e., Time Series, Box Plot, Probability Plot) in a GRITS Statistics module hold the **<Alt>** and **<P>** keys down at the same time.

   If you have selected a port (i.e., LPT1:, LPT2:) the printout will be sent to the printer attached to the selected port.

   If you have selected a Graph File a file will be created in GRITS Statistics directory. If you are in the **GRITS Statistics,Intervals Module** the Graph File will be created in the \GRITS500\MODULE1 directory. If you are in the **GRITS Statistics,ANOVA,Two-Sample,Control Chart Module** the Graph File will be created in the \GRITS500\MODULE2 directory.

   Printing a Graph Plot

   Graph Files must be printed with the MS DOS COPY command. To print a Graph File follow the instructions below:

   a. Exit **GRITS/STAT** to the MS DOS prompt.

   b. At the MS DOS prompt switch to the directory that contains your plot file.

If you created the Graph File in the **GRITS Statistics,Intervals Module** type:

<CD \GRITS500\MODULE1> <Enter>

Your DOS prompt should look like this:
C:\GRITS500\MODULE1>_.

If you created the Graph File in the **GRITS Statistics,ANOVA,Two-Sample,Control Chart Module** type:

<CD \GRITS500\MODULE2> <Enter>

Your DOS prompt should look like this:
C:\GRITS500\MODULE2>_.

c. Type the following MS DOS command:

<COPY /B *filename* LPT*n*:> <Enter>

where filename is the name of your Graph File and ***n*** the the port your printer is attached to.

Example: To print GRAPH.PLT to the printer attached to LPT1: type:

<COPY /B GRAPH.PLT LPT1:> <Enter>

For more information on MS DOS commands consult your MS DOS manual.

5.5.4 DATASET | VIEW | PRINT

The DataSet | View | Print option prints a textual list of observations and summary statistics to your local printer. To obtain a hard copy printout of the currently loaded data set follow the instructions below:

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**D**> to descend into the DataSet menu.

3. Press <**V**> to descend into the View menu.

4. Press <**R**> to execute the Print option. This will print a textual list of observations and summary statistics to your local printer.

5.5.5 DATASET | VIEW | SYSTEMSTATUS

The DataSet | View | SystemStatus option displays the currently selected data directory, the disk space available on the data directory drive, total conventional memory, a rough estimate of the maximum number of observations GRITS Statistics can load and the type of video adapter on your PC. To view the System Status dialog follow the steps below.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**D**> to descend into the DataSet menu.

3. Press <**V**> to descend into the View menu.

4. Press <**Y**> to execute the launch the System Status dialog (Figure 5-31).

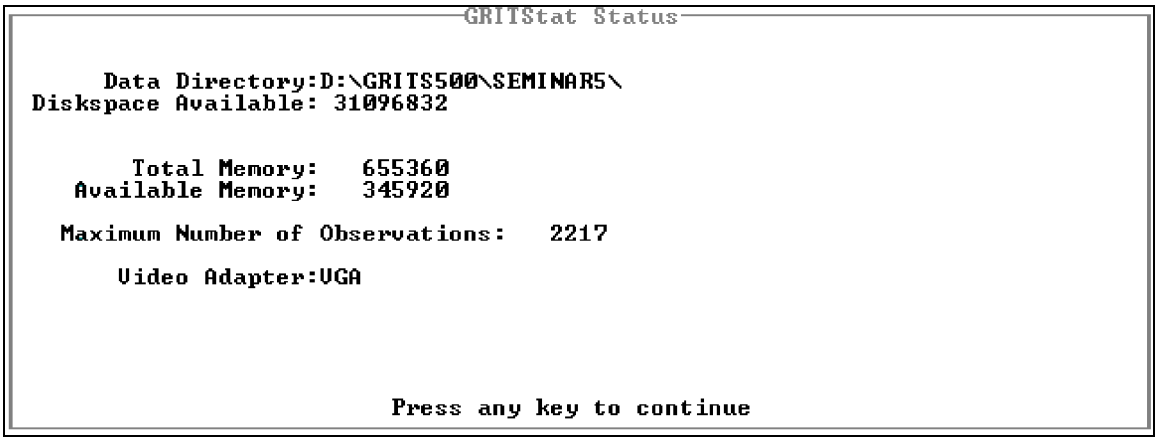


Figure 5-31. The System Status dialog.

5.6 THE METHODS MENU

The Methods menu in each GRITS Statistics module contains the statistical methods. Table 5-1 lists all statistical methods available in the **GRITS/STAT** Statistical Modules and the Module each method is located in. Both statistical modules contain Normality Tests (section 5.6.1), Probability Plots (section 5.6.2), Box Plots (section 5.6.3) and Levene's Test (section 5.6.4).

5.6.1 METHODS | NORMALITY | TESTS *(Both GRITS/STAT Statistical Modules)*

The Methods | Normality | Tests option performs the following Normality Tests:

- Skewness Coefficient
- Shapiro-Wilk (if the total number of observations is less than 50)
- Shapiro-Francia (if the total number of observations is 50 or more)

For statistical guidance on these tests consult Section 5.1 of the *Statistical Analysis of Groundwater Data: Unified Guidance*.

The instructions below assume that a data set is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**M**> to descend into the Methods menu.

3. Press <**N**> to descend into the Normality menu.

4. Press <**T**> to execute the Summary of Tests of Data Normality dialog (Figure 5-32).

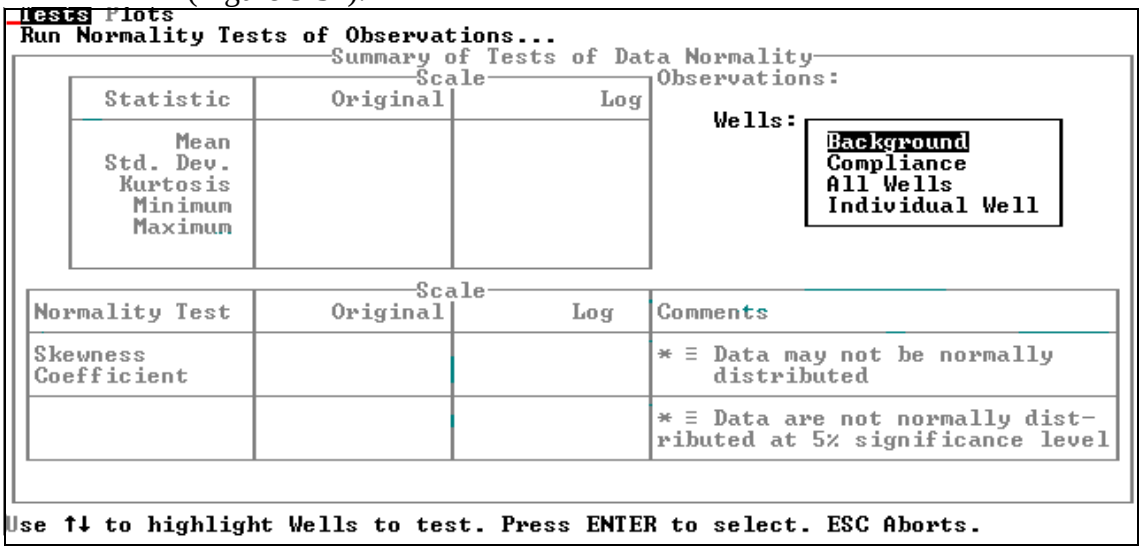


Figure 5-32. The Summary of Tests of Data Normality dialog.

5. Use the up and down arrow keys to highlight the desired Wells pooling option and press <**Enter**>. Each option in the list is described in Table 5-6.

Wells pop-up option	**Description**
Background	Data from all selected background wells will be pooled.
Compliance	Data from all selected Compliance Wells will be pooled.
All Wells	Data from all wells will be pooled.
Individual Well	Data from a single well will be used After selecting the Individual Well option a pop-up list of wells appears as shown in Figure 5-33. Use the up and down arrow keys to highlight the well you wish to test and press <**Enter**>.

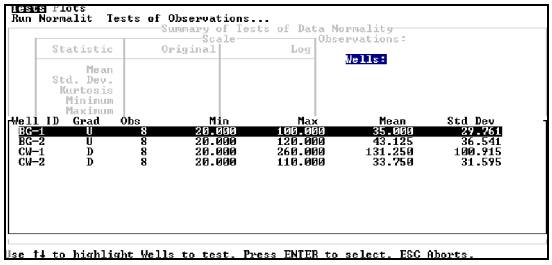


Figure 5-33. Pop-up Well Selection dialog

Table 5-6. The Wells pooling options.

6. The Test pop-up appears on your screen as shown in Figure 5-34.

Figure 5-34. The Test pop-up.

Select the Observations option to test the original observations for normality.

Select the Residuals option to test the residuals for normality.

Highlight the desired option and press <**Enter**>. Statistics and Normality Tests are computed on both the original and natural log (i.e., ln) transform

scale (Figure 5-35).

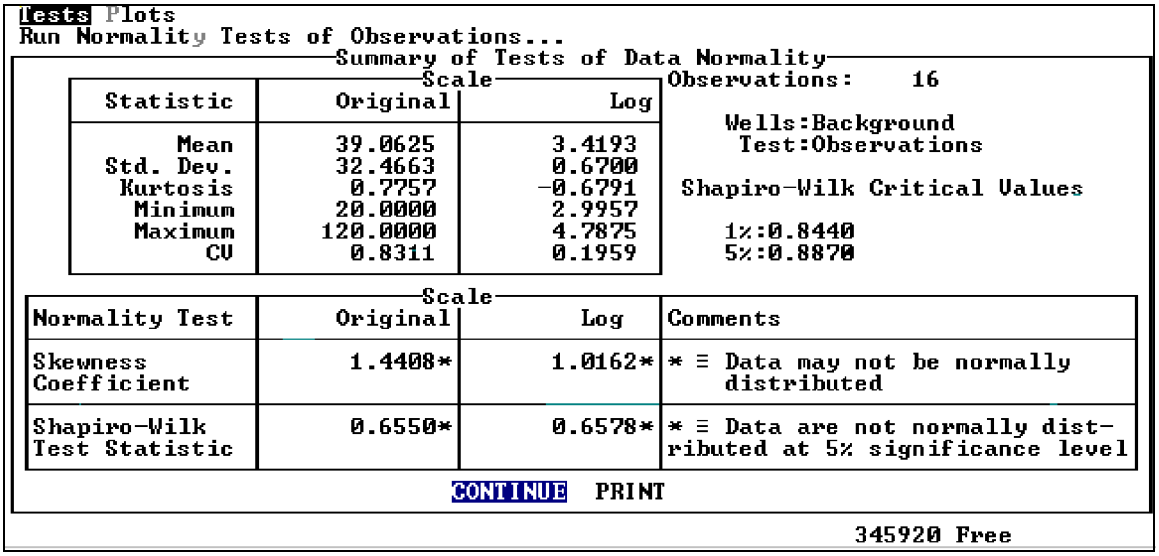


Figure 5-35. Summary of Tests of Data Normality dialog

The Skewness Coefficient and Shapiro-Wilk Statistic (or Shapiro-Francia Statistic for more than 50 observations) are computed for data on the original and ln scales. If the computed statistic indicates that the data may not be normally distributed an asterisk appears to the right of the statistic.

7. Two options appear at the bottom of the Summary of Tests of Data Normality dialog: CONTINUE and PRINT.

PRINT Option
The PRINT option prints the Summary of Tests of Data Normality dialog to your local printer.

CONTINUE Option
The CONTINUE option closes the Summary of Tests of Data Normality dialog and returns to the Methods | Normality menu.

Use the left and right arrow keys to highlight the desired option and press <**Enter**>.

5.6.2 METHODS | NORMALITY | PLOTS *(Both GRITS/STAT Statistical Modules)*

The Methods | Normality | Plots option:

- Produces a probability plot on user specified data
- Computes Filliben's Probability Plot Correlation Coefficient (r).

For statistical guidance consult of the Section 5.1 of *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <**M**> to descend into the Methods menu.

3. Press <**N**> to descend into the Normality menu.

4. Press <**P**> to execute the Plot option. The Probability Plot dialog shown in Figure 5-36 appears on your screen.

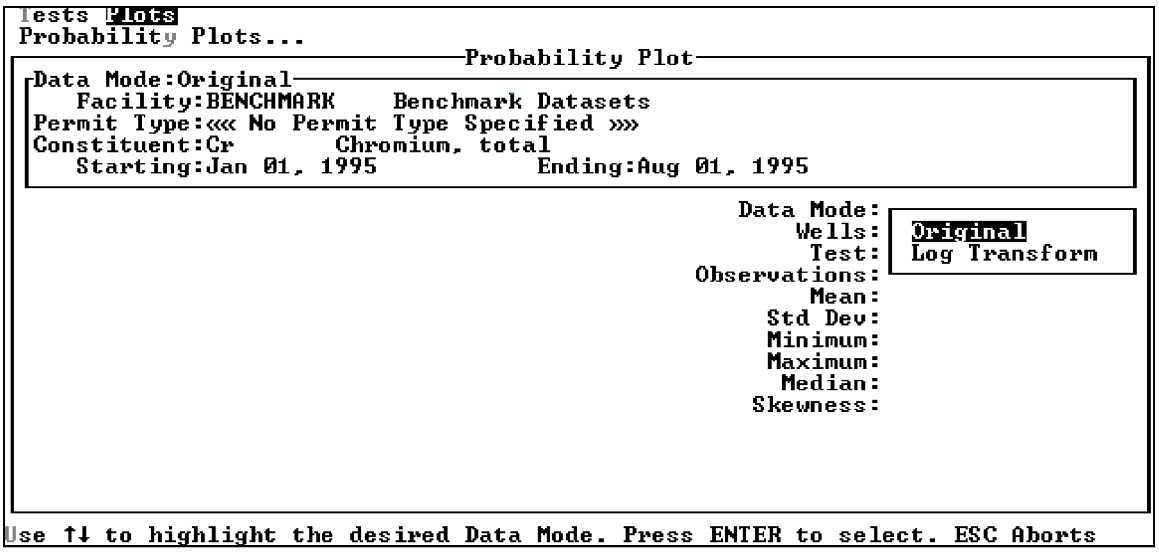


Figure 5-36. The Probability Plot dialog.

5. The two choices for Data Mode are Original and Log Transform.

   Select the Original option to produce a probability plot and compute Filliben's Probability Plot Correlation Coefficient on the raw untransformed data.

   Select the Log Transform option to produce a probability plot and compute Filliben's Probability Plot Correlation Coefficient on the natural logarithms of the selected data.

   Use the up and down arrow keys to highlight the desired option and press **<Enter>**.

6. The Wells prompt appears and prompts for pooling options (Figure 5-37). Pooling options are described in Table 5-6. Use the up and down arrow keys to highlight the desired option and press **<Enter>**.

Figure 5-37. The Wells prompt.

7. The Test pop-up appear on your screen as shown in Figure 5-34. Select the Observations option to produce a probability plot on observations.

   Select the Residuals option to produce a probability plot on residuals.

   Highlight the desired option and press <**Enter**>. Filliben's Correlation Coefficient for Probability Plots, Quantiles and summary statistics are computed for the selected data and displayed in the Probability Plot dialog (Figure 5-38).

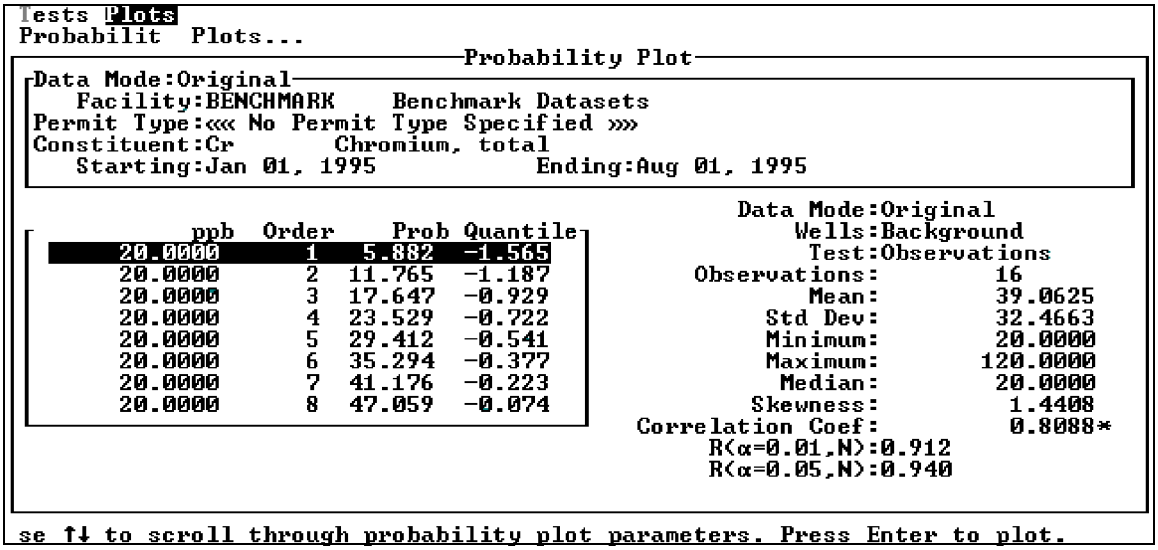


Figure 5-38. The Probability Plot dialog after data has been selected.

The computed Filliben's Correlation Coefficient is displayed to the right of the Correlation Coef. prompt. If the correlation coefficient is flagged with an asterisk (*) the data may not be normally distributed at the 1% level of significance.

The order statistics used to construct the probability plot are shown in a list box at the left of your screen. Use the up and down arrow keys to scroll through the order statistics. Press <**Enter**> when you are finished.

8. Three options become available: PRINT, PLOT and CONTINUE.

   PRINT Option
   To print the order statistics and summary statistics and the Filliben's Correlation Coefficient use your left and right arrow keys to highlight the PRINT option and press <**Enter**>.

PLOT Option
To proceed to the Probability Plot (Figure 5-39) use the left and right arrow keys to highlight PLOT and press <**Enter**>.

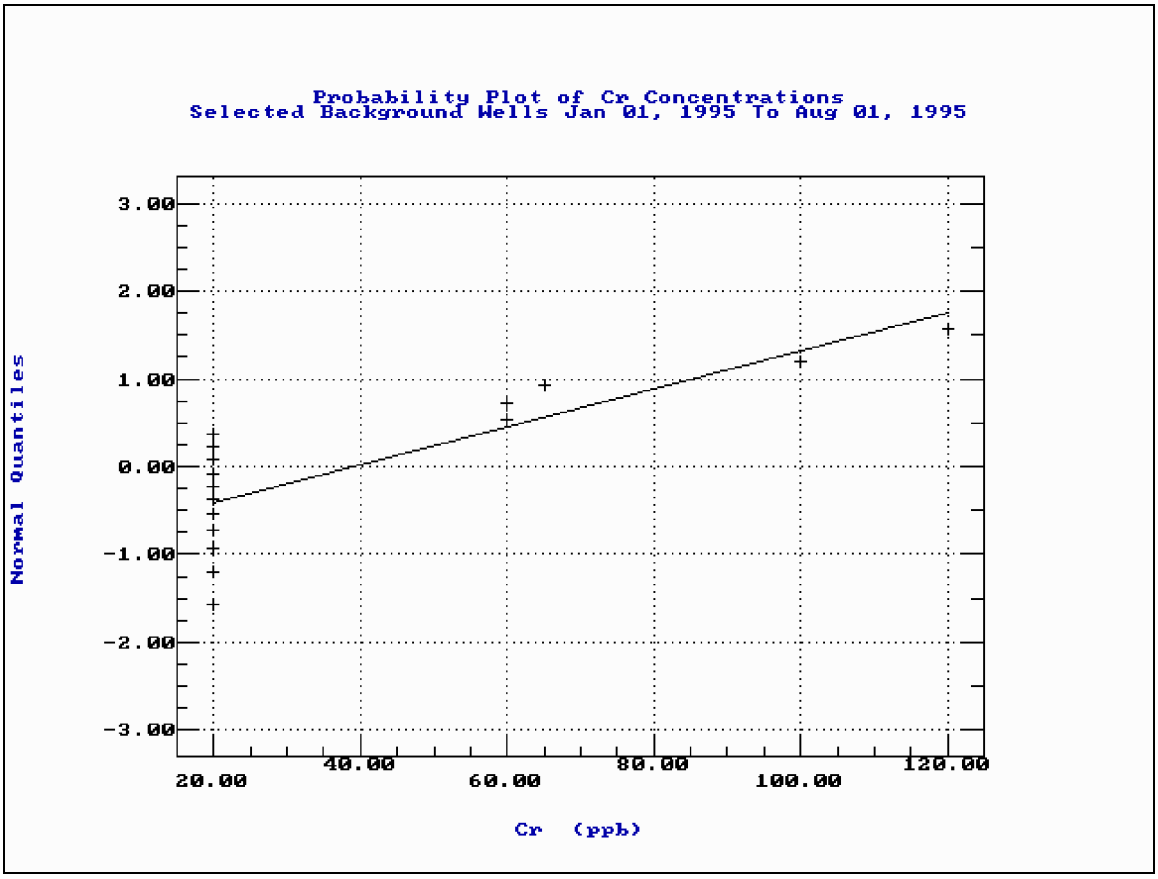


Figure 5-39. Probability Plot produced with the Methods | Normality | Plots option.

See Section 5.5.3.3 for instructions on printing the plot.

Press <**Esc**> to return to the Probability Plot dialog.

CONTINUE Option
To close the Probability Plot dialog and return to the Methods | Normality menu highlight the CONTINUE option and press <**Enter**>.

5.6.3 METHODS | VARIANCE | LEVENE'S TEST *(Both GRITS/STAT Statistical Modules)*

The Methods | Variance | Levene's Test option:

- Runs Levene's Test for Homogeneity of Variance on the currently loaded data set. Background wells are pooled together in one group and the individual compliance wells comprise the remaining groups.

> ***Note:*** The Levene's test implemented in GRITS Statistics automatically pools all selected background wells into one group. If you wish to exclude one or more background wells from Levene's test use the DataSet | View | Plot | Select option to toggle the well selection flags (Section 5.5.3.2).

For statistical guidance consult Section 5.2 of the *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press **<M>** to descend into the Methods menu.

3. Press **<V>** to descend into the Variance menu.

4. Press **<L>**. The Levene's Test dialog appears on your screen as shown in Figure 5-40.

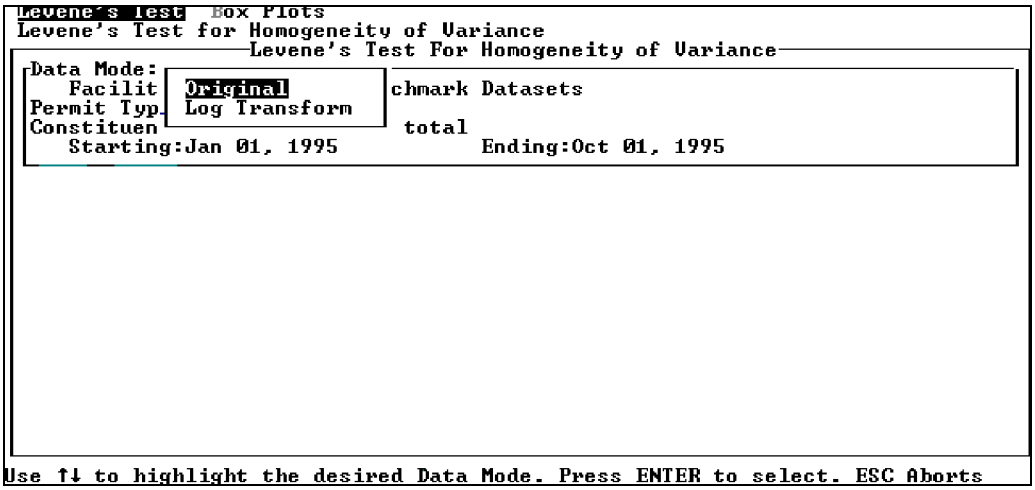


Figure 5-40. The Levene's Test dialog.

5. Highlight the Original option to perform Levene's Test on the original scale.

Highlight the Log Transform option to perform Levene's Test on the natural log scale.

Press **<Enter>**.

6. A pop-up appears on your screen and prompts you for the Significance Level (Figure 5-41). Enter the desired Significance Level and press **<Enter>**.

Figure 5-41. Prompt for the Significance Level.

7. The one-way ANOVA table is computed and displayed in the Levene's Test dialog.

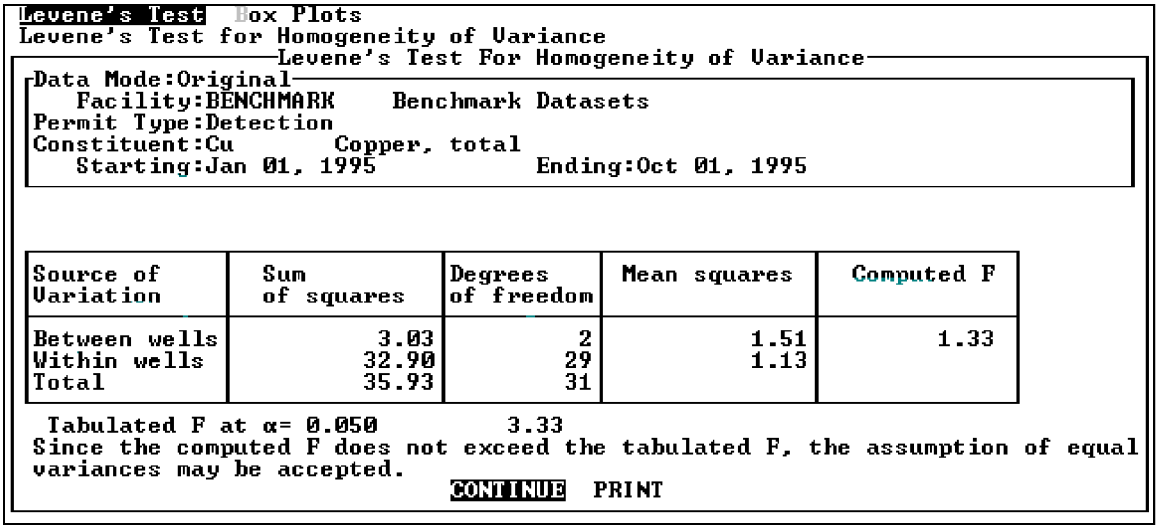


Figure 5-42. Levene's Test results.

8. The CONTINUE and PRINT options become available.

PRINT Option
Use the left and right arrow keys to highlight PRINT to print the results to your local printer.

CONTINUE Option
Highlight CONTINUE to return to the Methods | Variance menu.

Press <**Enter**>.

5.6.4 METHODS | VARIANCE | BOX PLOTS *(Both GRITS/STAT Statistical Modules)*

The Methods | Variance | Box Plots option:

- Produces Box Plots for each selected well and pooled Background Well data.

  For statistical guidance consult Section 5.2 of the *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

  The instructions below assume that a data set is loaded.

  1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

  2. Press <**M**> to descend into the Methods menu.

  3. Press <**V**> to descend into the Variance menu.

  4. Press <**B**> to execute the Box Plots option. The Box Plots dialog appears on your screen as shown in Figure 5-43.

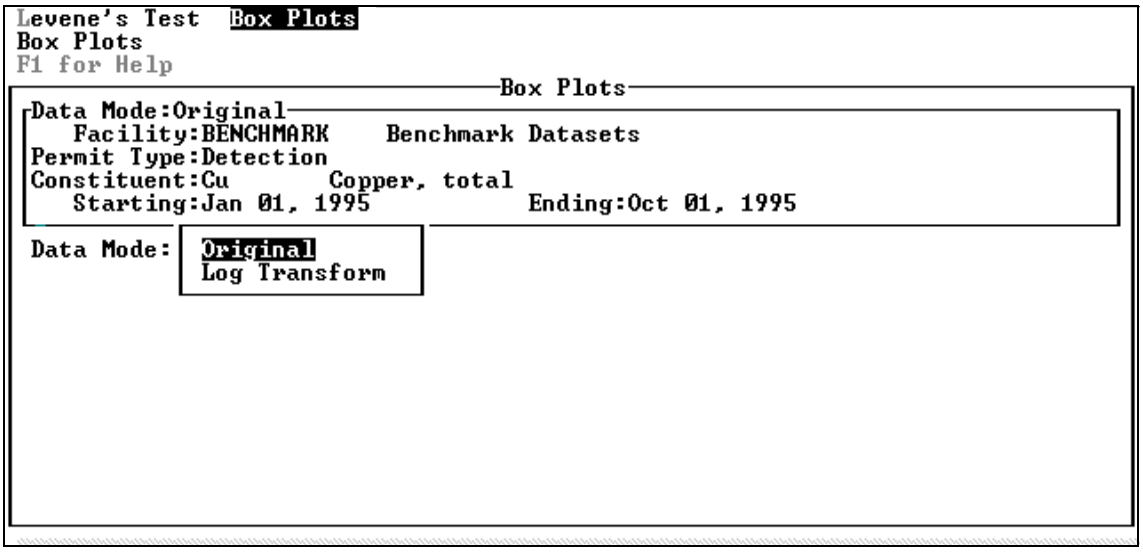


Figure 5-43. The Box Plots dialog.

5. Use the up and down arrow keys to highlight the desired Data Mode.

   Highlight Original to produce box plots on original data.

   Highlight Log Transform to produce box plots on log transformed data.

   Press <**Enter**>. The Test pop-up appears on your screen (Figure 5-34).

6. Highlight Observations to produce a box plot for observations.

   Highlight Residuals to produce a box plot for residuals.

   Press <**Enter**>.

7. A Percentile Summary appears on your screen as shown in Figure 5-44.